Vol. IX.—No. 41.] [APRIL, 1890.

THE

MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

Mineralogical Society.

INSTITUTED 3rd FEBRUARY, 1876.

EDITED BY A COMMITTEE OF COUNCIL.

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EXCERPT MINUTES OF COUNCIL MEETING.

Held in the Apartments of the Geological Society, November 5th, 1889.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

Dr. Hugo Müller was elected a member of the Editing Committee (in place of the retiring member, Professor Kinch).

An offer made by Professor Lewis to undertake the charge of the Library was accepted with thanks.

The following dates of meeting during the year 1890 were fixed:—January 14, March 18, May 20, November 11.

ANNIVERSARY MEETING.

Held in the Apartments of the Geological Society, November 5th, 1889.

H. R. Scott, Esq., M.A., F.R.S., President, in the Chair.

The following Report of Council was read and approved:—

REPORT.

The Balance Sheet for the year ending December 31, 1888, which was issued with No. 38 of the Journal, showed that the state of finances was not unsatisfactory. The excess of Assets over Liabilities was £215. 0s. 7d.

During the session 1888-1889 three ordinary Members have been elected, and a fourth has been reinstated; four Members (three of them resident abroad) have resigned, and one Member (Mr. Readwin) has been removed by death. The Society has to regret the decease of one of its most distinguished Corresponding Members, Professor Kjerulf. An obituary notice will appear in the Journal.

Five meetings have been held, all in London: the first was held in the Museum of Practical Geology, the others in the Apartments of the Geological Society.

Three numbers of the Journal have been issued: No. 38 in March, No. 39 in May, and No. 40 in October. No. 38 contained papers on Scotch Minerals, by Professor Heddle, Professor Macadam and Mr. Morrison, and a description of a new form of

microscope, by Mr. Dick ; the contents of No. 39 were various, and included a paper, by Professor Judd, on the Processes by which a Plagioclase-felspar is converted into a Scapolite. Of the papers contained in No. 40, attention may be called to a detailed discussion of the Meteorites of Atacama, by the Secretary ; and to a paper, by Professor McKenny Hughes, on the manner of occurrence of Beekite. It may be added, that the cost of two of the plates in the above numbers has been defrayed by the authors of the corresponding papers, Professor Judd and the Secretary.

The Council would again remind the Society, that, for the proper maintenance of the Journal, it is desirable that there should be an increase in the number of Members who contribute papers. An addition to the number of Members of the Society would render a more frequent issue of the Journal financially practicable.

The following were elected Officers and Council for the ensuing year :—

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A. Harker, M.A., F.G.S.
Prof. W. J. Lewis, M.A., F.C.S.

Mr. B. Kitto, F.G.S., and Mr. F. W. Rudler, F.G.S., were re-elected Editors.

A vote of thanks to Mr. Miers for his Index to Mineralogical Papers was passed.

A vote of thanks to Professor Lewis for his offer to take charge of the Library was passed.

A vote of thanks to the Geological Society for its kindness in allowing the Mineralogical Society the use of a room for its meetings was passed.

A vote of thanks to the retiring Members of the Council (Professor Judd, Professor Kinch, Professor Macadam, and Mr. Teall) was passed.

The following papers were read :—

"On the Hemimorphism of Stephanite," by H. A. Miers, M.A. (page 1.)

"On the Crystalline form of Kaolinite," by the same. (page 4.)

"On Oxide of Zinc from a Blast Furnace," by J. T. Cundall, F.C.S., and A. Hutchinson, B.A. (page 5.)

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THE MINERALOGICAL MAGAZINE

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MINERALOGICAL SOCIETY.

No. 41. APRIL, 1890. Vol. IX.

The Hemimorphism of Stephanite: the crystalline form of Kaolinite.

By H. A. Miers, M.A.

[Read November 5th, 1889.]

(*a*). *The Hemimorphism of Stephanite.*

STEPHANITE has been the subject of two important memoirs. Schröder[1] examined minutely the crystals from Andreasberg; Vrba[2] has described fully the character of the stephanite from Przibram and other localities, and has given at the same time a summary of the observations of previous mineralogists, so that his memoir constitutes a monograph of the mineral.

By neither of these observers, however, nor elsewhere, has it been stated that stephanite is hemimorphic, although it has been suspected of being possibly hemihedral.

It is the object of the present paper to establish the hemimorphism of

[1] *Pogg. Ann.* 95 (1855), p. 257.

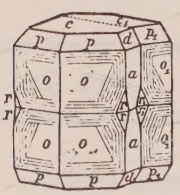
[2] *Ber. Böhm. Ges.* (1886), p. 119.

stephanite upon evidence similar to that which has been employed in the case of pyrargyrite.

With regard to the latter mineral it has been shown by M. Schuster[1] and myself[2] that certain striæ upon the prism faces are unsymmetrical since they point to one end of the crystal alone; and further, that when they occur at both ends they are accompanied by certain indications of twinning which show the crystal to be in reality a combination of two hemimorphic prisms attached to each other by their similar ends. This twinning tends to disguise the hemimorphic character of the crystals.

A similar striation and the same mode of twinning may now be shown to exist in stephanite.

The accompanying figure represents a combination of the forms :—



$c = 001 = \text{o}\breve{\text{P}}$
$a = 100 = \infty\breve{\text{P}}\infty$
$o = 110 = \infty\text{P}$
$d = 201 = 2\breve{\text{P}}\infty$
$P = 111 = \text{P}$

twinned upon the face $\bar{1}10$: the two individuals are combined parallel to the twin-plane which is indicated by the dotted line upon *c*.

The faces *c* *P* and *d* are generally smooth and bright, except when traversed by twin laminæ parallel to faces of the forms $110 = \infty\text{P}$ and $310 = \infty\breve{\text{P}}3$; the brachypinakoid *a* is striated horizontally and vertically.

The prism *o* is sometimes smooth and sometimes striated horizontally and vertically; but on the crystals which are the subject of the present note, it is characterised by an oblique striation of special significance inclined at an angle of 23° 21½′ to the prism edge.

If now the attention be confined to the upper half of the figure, it will be seen that these striæ are exhibited upon each face of the prism *o*, and that they run in one direction parallel to its intersections with the form $\Gamma = 731 = 7\breve{\text{P}}\frac{7}{3}$.

The lines are only parallel to those faces of Γ which are situated at the lower end of the prism, and are therefore sufficient in themselves to indicate a want of complete symmetry; but the hemimorphic character is more clearly displayed when the form Γ is developed and presents small bright planes which are then to be found at one end of the crystal alone.

The figure further illustrates another feature which is characteristic of

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[1] *Zeits. f. Krystallographie* 12 (1887), p. 117.

[2] *Min. Mag.* vii. pp. 71, 79, and *Zeits. f. Kryst.* 15 (1889), pp. 160, 168.

most, though not of all, of the hemimorphic crystals. The middle of the prism is traversed by a line of junction parallel to the basal plane c, dividing the crystal into two symmetrical halves. The upper half has oblique striations parallel to the faces of Γ situated at its lower end; the lower has the striations parallel to Γ at its upper end; so that these faces when present give rise to small re-entrant angles at the junction of the two individuals.

Such crystals must be regarded as twins precisely similar to those of the hemimorphic zinc-silicate, two crystals being united so as to be symmetrical to the basal plane.

If described as a hemitropy the twins must be geometrically defined as due to twinning about either the macropinakoid 010 or the brachypinakoid 100 with composition parallel to the basal plane; they are analogous to the twins of pyrargyrite described in vol. viii. p. 79 as due to twinning about the prism $10\bar{1} = \infty P2$ with composition parallel to the basal plane.

The two individuals are usually united by their Γ ends (ends at which the form Γ occurs), but sometimes the Γ faces are at the ends opposite to those by which the prisms are united; in this respect also they are analogous to pyrargyrite.

It is another peculiar feature of the crystals that, as is shown in the figure, this mode of twinning is generally combined with the almost universal twin-structure of stephanite which results from hemitropy about the planes $o = 110$.

A prism may, therefore, in addition to the hemimorphic twinning, consist of two or more individuals twinned about faces of the form 110, or may be traversed by twin laminæ parallel to those faces.

Upon some crystals, which appear at first sight holosymmetrical, the prism faces show striations at both ends without any signs of twinning; but on closer examination they prove to be totally distinct; those at one end are the striæ described above, which are inclined to the prism edge at the angle 23° 21½′, are formed by the faces $\Gamma = 731 = 7\breve{P}\frac{7}{3}$, and belong to the zone $[\bar{1}14]$ containing the form $e = 401 = 4\breve{P}\infty$; while those at the other end are inclined to the prism edge at the angle 40° 46′, are formed by the faces $\rho = 421 = 4\breve{P}2$, and belong to the zone $[\bar{1}12]$ containing the form $d = 201 = 2\breve{P}\infty$.

The latter striation is mentioned by Vrba as common on stephanite from Andreasberg.

When a twin crystal has Γ at its outer ends, the striæ and the re-entrant angles which indicate the line of junction are formed, not by Γ, but by the faces ρ, d, and belong to the latter series.

The two ends of a stephanite prism are therefore to be distinguished; one is characterised by Γ and by striations belonging to the zone $[\bar{1}14]$, the other by ρ and by striations belonging to the zone $[\bar{1}12]$; the direction of these striations, when they are visible, will always show to which end any part of a crystal is to be referred.

My attention was first attracted by the above peculiarities in crystals from Wheal Boys, Endellion, but I have subsequently observed the same indications of hemimorphism in Stephanite from Freiberg, Andreasberg, Gersdorf, Guanaxuato, and Chañarcillo.

(b). The Crystalline form of Kaolinite.

The length of the vertical axis of this mineral given in vol. viii. p. 25 is not correct.

If deduced from the measurements (p. 24) of the crystal represented in Fig. 34, Plate iii., the crystallographic elements are—

$$\beta = 83° 11'$$
$$a : b : c = 0{\cdot}5748 : 1 : 1{\cdot}5997,$$

the angles being

	Measured.	Calculated.
$b\ m$	60° 17′	
$c\ m$	84° 5′	
$c\ n$	78° 8′	
$b\ n$	60° 44′	60° 8½′.

On Zinc Oxide from a Blast-furnace.

By J. Tudor Cundall, B.Sc., F.C.S.,

Lecturer and Demonstrator of Chemistry in University College, Cardiff.

With a Crystallographic Examination of the same by

A. Hutchinson, B.A.,

Scholar of Christ's College, Cambridge.

[Read November 5th, 1889.]

A CRYSTALLISED substance from a blast-furnace at Mostyn, in N. Wales, having been brought under my notice by Mr. Heywood, of St. Mellons, it was thought worth while to subject it to a careful examination. The largest of the crystals was about 6 mm. long and 2 mm. in diameter. They were translucent, varying in colour from almost colourless to honey-yellow, and were arranged in tufts on what seemed to be altered firebrick. They yielded a pale yellow powder of which the specific gravity was found to be 5·605.

Two different portions were analysed, with the following results :—

		I.	II.
ZnO	...	97·96	98·79
Pb	...	1·02	0·95
S	...	·39	·10
SiO_2	...	·61	trace
FeO	...	·39	trace
		100·37	99·84

In both cases the powder was soluble in dilute hydrochloric acid, with the exception of some glittering grains of lead sulphide.

In I., however, excess of sulphur was present as sulphide decomposed by acids, but in II. the lead was in excess, and present in the metallic state in minute globules. The silica and iron were probably derived from imperfect separation from the matrix.

This substance, then, consists of almost pure zinc oxide, and is deposited in cavities in the wall of the furnace at about its widest part.

(The furnace was used for the preparation of "spiegeleisen" from an ore containing a considerable quantity of zinc.)

The zinc is apparently volatilised as such, and diffuses into these cavities, where in some cases it becomes oxidised, but in others, when access of oxygen is denied, metallic zinc is deposited.

Crystallographic Examination.—The crystals of zinc oxide sent me by Mr. Cundall as suitable for measurement are small, being about 3 mm. long and from 1-2 mm. in diameter.

They belong to the rhombohedral system, and some few of them are simple doubly-terminated hexagonal pyramids $\{51\bar{3}\}$; the greater number, however, exhibit the following combination of forms:—
$a\ \{10\bar{1}\}$, $o\ \{111\}$, $f\ \{2117, 13\}$, $k\ \{531\}$, $m\ \{210\}$, $x\ \{31\bar{1}\}$, and $y\ \{51\bar{3}\}$. Owing to the development of the crystals in tufts, no doubly-terminated specimen of this habit was to be found, and hemimorphism could not therefore be detected. On one crystal the rhombohedron $r\ \{100\}$ occurred in combination with $a\ \{10\bar{1}\}$, $o\ \{111\}$, and $y\ \{51\bar{3}\}$. The angle $o\,r$ was not, however, capable of very accurate measurement, and the element 111:100 was therefore calculated from the very good readings = 31°·40′ obtained for the angle ok; the resulting value of 111:100 is 58°·2′, while ox = 61°·37′ and xx' = 52°·12′. These crystals possess a fair cleavage parallel to the base $o\ \{111\}$, and a perfect one parallel to the faces of the prism $a\ \{10\bar{1}\}$. They are interesting as exhibiting the new faces $r\ \{100\}$ and $f\ \{21\ 17\ 13\}$, and for being much richer in forms than others hitherto described.

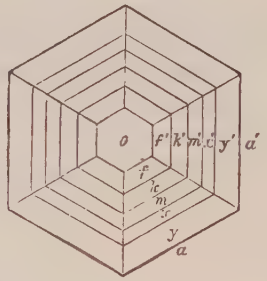
The somewhat high indices {21, 17, 13} are not to be regarded as certain, for although they agree best with the observed value of the angle $o\,f$=12° 14′ (calculated=12° 17′) the faces of this form are rounded and give indefinite reflections; the simpler indices {543} require $o\,f$=13° 1′.

Crystals similar to these have often been observed as furnace products, and in addition to the forms $a\ o\ r\ f\ k\ m\ x$ and y, the following have from time to time been described: $b\ \{2\bar{1}\bar{1}\}$, $l\ \{951\}$, $w\ \{73\bar{1}\}$, $d\ \{11,3,3\}$, $e\ \{11,2,\bar{2}\}$, $s\ \{911\}$, and its dirhombohedral form $\sigma\ \{\bar{3}75\}$.

I append a list of the observed angles, comparing them with those calculated from the element 58° 2′, together with a resumé of the literature.

Angle.	Calculated.	Measured.	
	° ′	° ′	
$o\,r$	58 2	58 10	
$o\,d$	37 1		
$o\,e$	71 25½	71 26	(Koch)
$o\,f$	12 17	12 14	
$o\,k$	—	*31 40	

Angle.	Calculated.	Measured.	
	° ′	° ′	
$o\,l$	36 31	36 58	(V. Rath)
$o\,m$	42 47	42 36	
$o\,w$	50 59	50 0	(Koch)
$o\,x$	61 37	61 37	
$c\,y$	74 53	74 50	
$o\,s$	58 30		
$s\,a$	36 19		
$s\,s'$	18 34	18 45	(V. Rath)
$s\,\sigma$	32 24	32 25	(,,)
$d\,a$	58 34	58 30	(Des Cloizeaux)
$d\,d'$	62 52	63 30	(,,)
$x\,x'$	52 12	51 48	
$z\,z'$	57 44	57 45	



The forms $o\,e\,w\,a$ were observed by Koch (*Beitr. z. Kenntniss Kryst. Hüttenprod. Göttingen*, 1822); see also Hausmann (*Handb. d. Mineralogie*, 1847, II. 198). Schabus (*Wien. Ak. Ber.*, 11, 8) and Lévy (*Ann. d. Mines* [4] 4, 516) both observed the combination $a\,o\,x$; the former takes for his element $x\,x' = 52° 17½'$, while Lévy selects $o\,x = 62° 20'$, whence $x\,x' = 52° 34'$.

The same combination has more recently been observed by Rinne (*N. Jahrb. f. Min.* 1888, II. 164-171): he finds $o\,x = 61° 54'$, whence $x\,x^1 = 52° 21'$, his crystals are moreover hemimorphic, as shown both by their development and their etched figures.

Vom Rath (*Pogg. Ann.* 1864, 122, 406; 1872, 144, 580) has described the combination $s\,\sigma\,o\,a$ and a twin exhibiting the forms $a\,b\,o\,l\,x$; he adopts as his element $o\,x = 62° 1'$, and finds that the crystal is twinned about a face of the hexagonal pyramid which makes an angle of 59° 8′ with $o\{111\}$, hence it has the indices $\{25,9,7\}$, and taking $ox = 61° 37'$ this angle becomes 58° 42′: the plane of combination is perpendicular to the twin plane.

The rhombohedron $d\{11,3,3\}$ was found by Des Cloizeaux (*Ann. d. Mines* [4] 1,488) on some crystals formed in cavities in roasted blende; see also Brooke and Miller (*Mineralogy*, 1852, 218).

A large series of crystals from various furnaces have recently been investigated by Greim (*Ber. d. Oberhess. Ges. f. Nat. u. Heilk*, 1886, 24, 29), who described for the first time the forms k, m and y, all of which are present on the crystals I have examined; our values for the angle $o\,k$

are identical; the form $w\{915\}$, described by Greim as new ($o\,w = 50°59'$), is probably the same as that already observed by Koch ($o\,w = 50°$).

Firket (*Ann. Soc. Géol., Belg.*, 1885, 12 Bull. 191) and Gorgeu (*Bull. Soc. Min. France*, 1887, 10, 36) have also observed the artificial formation of zinc oxide crystals.

The above measurements were made in the Cambridge Mineralogical Laboratory, and my best thanks are due to Prof. Lewis for much kind assistance and advice, and to Mr. Solly for the loan of his Fuess goniometer.

On Zinc Sulphide replacing Stibnite and Orpiment; Analyses of Stephanite and Polybasite.

By G. T. Prior, M.A.
Assistant in the Mineral Department, British Museum.

[Read January 14th, 1890.]

(*a*) Zinc Sulphide replacing Stibnite.

In a paper in *Zts. f. Kryst.* IX. 186, Professor Laspeyres states that the yellow encrustation upon Felsöbanya stibnite is not cervantite, but a sulphide of zinc, which he determines to be wurtzite, chiefly on the optical ground that a black interference cross was observed between crossed nicols, for the chemical proof based on the solubility in cold concentrated hydrochloric acid can hardly be regarded as very conclusive, considering the fact that he had no true wurtzite with which to make the comparison, but only so-called schalenblende, spiauterite, etc. On this account it seemed desirable to test the solubility of wurtzite in HCl, and accordingly a series of experiments as to the comparative solubility of wurtzite, spiauterite, voltzite and different varieties of blende was made by treating small fragments with cold concentrated HCl, (as was done by Professor Laspeyres) in small tubes, in the mouth of which strips of lead acetate paper were inserted. As far as could be judged by these experiments, the order of solubility was as follows:—

The encrustation: very readily attacked and quickly dissolved.

Voltzite from Joachimsthal and from Geroldseck: attacked at once very readily.

Light-brown botryoidal blende from Wolkenstein, Saxony: attacked at once, almost as readily as voltzite.

So-called ribbon blende from Belgium: freely attacked at once.

Ordinary botryoidal blende from Cornwall: slightly attacked after short time.

Spiauterite from Kapnik, Hungary: slightly attacked after short time.

Wurtzite from Oruro, Bolivia: slightly attacked after some time.

Deep red crystallised blende from Pzribram: scarcely affected at all after standing for several hours.

A qualitative examination of the yellow crust on all the stibnites from Felsöbanya in the Museum collection showed that in all cases it consisted of zinc sulphide very freely soluble in cold concentrated HCl. On one specimen in which the stibnite in radiating groups was associated with a mass of small quartz crystals, the zinc sulphide occurred partly in the usual form as an encrustation on the crystals and partly as an earthy mass of a dull yellowish colour at the root of the crystal. This mass, very different in appearance from the ordinary honey-yellow encrustation, was so thick that ·3901 gramme could be removed for analysis. It was found to contain—

Zn = 59·22 p.c.
S = 27·85
Sb = 2·2

which, assuming that the antimony occurred as oxide, gives for the atomic proportion of zinc to sulphur—

Zn	:	S
·911	:	·870
or 1·05	:	1

The excess of Zn over S may be due to the presence of oxide, but the difference is perhaps hardly sufficient to support the idea suggested by the above table of solubility, that the encrustation is more closely related to voltzite than to wurtzite.

The specific gravity of the mass was 3·44 at 18° C.

In order to discover whether this peculiar encrustation was restricted to stibnite from Felsöbanya, an examination of the deposit on stibnite from other localities in the Museum collection was made, with the result that two new localities may now be added, viz. Estremadura, Spain, and Siegen, Prussia. On all other specimens the encrustation was found to consist of one or more of the oxides of antimony.

The Siegen specimen, which had been described as "antimonglanz passing into valentinite," was remarkable for the thickness of the deposit, which did not, as in Felsöbanya specimens, form a thin coating, but wholly replaced the terminations of the stibnite crystals, which occurred in small radiating groups on brown spar.

A precisely similar encrustation of zinc sulphide was subsequently found coating and partly replacing botryoidal orpiment on a specimen from Felsöbanya.

(*b*) Stephanite.

(1) *From Copiapo, Chili.*

The specimen, in size about 5 cm. × 3 cm., without matrix, consists a group of large stout prisms, with individuals about 15 mm. in length nd 20 mm. broad. It was chosen for analysis from its appearance of urity; for, unlike most of the stephanites examined, no pyrargyrite ould be detected on it, and when broken into small particles and exnined under the microscope by strong transmitted light, the only impurity und consisted of one or two deep red scales of polybasite. The traces of ı and As found in analysis were no doubt due to this intermixed polyite. The mineral was decomposed in chlorine, and analysis conducted methods given in *Min. Mag.* VII. p. 128.

Result of analysis:—

Ag	= 68·65
Sb	= 15·22
S	= 16·02
Cu	trace
As	trace
	99·89

S.G. = 6·26 at 16°C. Weight used in analysis—

For Ag and Sb ... 1·0418 grms.
For S ... ... ·5393 „

The atomic proportions are—

	Ag	= ·636	
	Sb	= ·127	
	S	= ·500	
or approximately	Ag	Sb	S
	5	1	4

ich corresponds to the formula now generally adopted for stephanite, $Ag_5 S. Sb_2 S_3$, and not $6 Ag_2 S. Sb_2 S_3$, as taken by Rose and still given some text-books.

The following forms have been observed on the specimen by Mr. H. A. ers:—

c	001	OP
d	201	$2P\infty$
k	101	$\breve{P}\infty$
f	313	$\breve{P}3$
P	111	P

(2) *From Wheal Boys, Cornwall.*

Only two Cornish specimens of stephanite have hitherto been described viz. one from Wheal Ludcott by Mr. Davies (*Geol. Mag.* 3, 432), and a large crystal from Wheal Newton by Prof. Lewis (*Zeit. f. Kryst.* VII p. 575). The present specimen consists of bright prisms attaining a length of 13 mm., on quartz which, in parts is coated with minutely crystalline mispickel.

It was thought that an analysis of the specimen might be of interest, since none had hitherto been made on Cornish stephanite.

Unfortunately for the analysis, the crystals of stephanite were found to be interpenetrated in an extraordinary way with pyrargyrite.

To ordinary observation, even with the aid of a lens, the mineral appeared to be pure, and it was only when examining it in strong sunlight that the red light transmitted through small particles of pyrargyrite could be detected on every freshly-exposed surface.

For the specific gravity determination the mineral was broken into small particles and all visible pyrargyrite separated. This specific gravity cannot altogether represent that of the analysed material, since in the subsequent crushing more pyrargyrite was removed. Each of the small particles was separately flattened out under the pestle, and the intimate nature of the mechanical mixture of the two minerals may be judged by the fact, that when treated in this way few particles were found which did not show thin streaks of red pyrargyrite running through the main mass of the stephanite. The particles containing no pyrargyrite would not have been sufficient for analysis, and so a rough separation of the two minerals had to be made as well as possible on the flattened-out particles. This separation could naturally not be perfect, and accordingly the analysis indicates the presence of pyrargyrite by the low p.c. of Ag and high p.c. of Sb., as compared with analysis (1). Making allowance, however, for this slight admixture with pyrargyrite, the analysis shows that stephanite from Cornwall and stephanite from Copiapo are identical in composition.

Result of analysis :—

Ag	= 68·21
Sb	= 15·86
S	= 15·95
Fe	trace
	100·02

S.G. = 6·24 at 17°C.

Weight used for Ag and Sb = ·9704 grms.
for S ·5032 ,,

The following remarks on the crystalline form of the two Cornish specimens from Wheal Ludcott and Wheal Boys have been contributed by Mr. H. A. Miers:—"The crystals from Wheal Ludcott on the specimen described by Mr. Davies in 1866 are small bright prisms exhibiting a combination of the forms—

c	001	OP
o	110	∞P
m	113	$\frac{1}{3}$P
h	112	$\frac{1}{2}$P
P	111	P
t	203	$\frac{2}{3}\breve{P}\infty$
k	101	$\breve{P}\infty$
d	201	$2\breve{P}\infty$

and are compound crystals twinned both upon the planes 110 and 310.

The crystals from Wheal Boys are large bright prisms attaining a length of 13 mm. and exhibiting a combination of the forms—

c	001	OP
P	111	P
β	011	$\bar{P}\infty$
h	112	$\frac{1}{2}$P
o	110	∞P
λ	130	$\infty\bar{P}3$
a	100	$\infty P\infty$
Γ	731	$7\breve{P}\frac{7}{3}$
d	201	$2\breve{P}\infty$

They are also twinned both upon the planes 110 and 310 and further show the hemimorphic character and twin structure described in *Min. Mag.* Vol. IX. p. 2.

The hemimorphism and the twinning with parallel axes are betrayed by the faces of Γ which occur only on the inner ends of the individuals and lead to unsymmetrical striations on the bright faces of *o*."

(*c*.) Polybasite.

From Santa Lucia Mine, Guanaxuato, Mexico.

This specimen consists of a group without matrix, of polysynthetic hexagonal tables about 20 mm. in length and 6 to 10 mm. in thickness. The material was very carefully examined for impurities and enclosed minerals. As before, each particle was separately flattened out under the pestle, but no pyrargyrite or argentite was detected in this way. Whether a little stephanite was mixed with the polybasite it would be impossible to

say. The result of this analysis as well as of many of those hitherto published would seem to imply that such may be the case, but owing to the similarity in appearance of the two minerals such a mixture as occurred for instance, in the case of the Cornish stephanite could not be optically detected. In breaking up the crystals slight differences in lustre in different parts were noticed, but otherwise the material appeared to be quite homogeneous, and no mineral which could account for the copper in any other way than as a normal constituent of the polybasite could be discovered.

The only impurity found, consisted of one or two very small particles with bright yellow metallic lustre, which were easily detected and removed owing to their perfect malleability, which caused them to be flattened out under the pestle in the process of crushing the material for analysis. There was very little of this impurity to deal with, little over a milligram, but a chemical examination with the help of the microscope showed, without doubt, that it consisted of an electrum or gold containing a large proportion of silver. Heated to redness in a small glass tube over the Bunsen flame, it suffered no change whatever, but it fused to a bright yellow malleable metallic globule when exposed for some time to the blowpipe-flame in a small porcelain crucible. Repeated evaporations on a watch-glass with nitric acid appeared to have very little effect upon it. It was only by heating in aqua-regia that it lost its metallic appearance, but did not dissolve readily owing to the layer of silver chloride (found to be soluble in ammonia), which protected the metal beneath: however, by rubbing with the rounded end of a glass rod and exposing the fresh surface beneath, sufficient gold was dissolved to give the purple of Cassius very distinctly. A comparative test made upon a pale specimen of electrum rich in silver showed that it behaved in a precisely similar way with respect to acids.

In the analysis the chlorides of silver and copper left after the decomposition of the mineral in chlorine were reduced in hydrogen, and the resulting metals dissolved in nitric acid. The silver was estimated as chloride and the copper as cuprous sulphide. The arsenic was separated from the antimony by Classen's method.

Result of analysis :—

Ag	= 68·39
Cu	= 5·13
Sb	= 10·64
As	= 0·50
S	= 15·43
	100·09

Specific gravity = 6·33 at 15° C.

Weight used in analysis :—

For Ag, &c.	1·0760
S	·5013

The atomic proportions deduced from the analysis are :—

Ag	= ·634
Cu	= ·081
Sb	= ·089
As	= ·006
S	= ·481

approximately

Ag, Cu	Sb. As.	S.
$7\frac{1}{2}$	1	5

If Rose's formula $9Ag_2S.Sb_2S_3$ be considered the correct one for polybasite, the above result, like many of those hitherto published, would imply that the specimens contained intermixed stephanite. This idea is supported by the fact that in the analysis of Rose, which approximates best nearly to the formula $9Ag_2S.Sb_2S_3$, there is practically no antimony, so that in this case no stephanite could have been present. It would be interesting to learn, if it were possible, in what respects that particular specimen differed from ordinary polybasite, since it might be almost regarded as another species as distinct from polybasite as proustite is from pyrargyrite.

The specific gravity determinations were made with a 3cc. pyknometer provided with a thermometer-stopper and graduated side tube as described in Graham-Otto's text-book.

Results obtained with this little instrument are surprisingly constant. With stopper very slightly greased, when exactly the same course of procedure is pursued in every detail and in the same order, the difference in the weighings seldom exceeds 0·3 mg., if the temperature is kept constant.

The Meteoric Iron of Tucson.

By L. Fletcher, M.A., F.R.S. (General Secretary),
Keeper of Minerals in the British Museum.

[Read March 18th, 1890.]

1. TWO large masses of meteoric iron, which have been removed from Tucson, are now preserved, the one at Washington, the other a San Francisco. According to Lippincott's Gazetteer, Tucson is "a post town, capital of Pima County, Arizona, U.S.A., on the Rio Santa Cruz and on the Southern Pacific Railroad, about 250 miles east of Yuma. It was founded in the year 1560 by the Jesuits. It contains a church, th Institute of St. Joseph, two free schools, a bank, a newspaper office, court-house, a United States depository, many stores, and two flour mills The population in 1880 was 7,007."

Le Conte.

2. Attention was called to the iron of Tucson by Dr. John L. L Conte of Philadelphia, a distinguished entomologist, in an oral statemen made by him at a meeting of the American Association for the Advance ment of Science, held at Albany in August 1851. Two accounts of thi statement have been published. According to the first and brief offici account,[1] Dr. Le Conte, "while passing through the village of Tucson i the preceding February, had observed two large pieces of meteoric iron i use by the blacksmiths of the town as anvils." They were irregular i form; and although imbedded in the ground to make them steady for us they were about three feet high. Notwithstanding the offer of a hig price, "he was unable to get any bits broken from the anvils, but wa guided to a cañon between two mountain-ridges in the immediate vicinity from which both pieces had been taken, where the masses of the me teorites were so abundant as to have given name to the cañon."

In the second and more detailed report[2] of his statement no mention a

[1] *Proc. Amer. Assoc. for Adv. of Sci.*, p. 188.
[2] *Amer. Jour. Sci.*, 1852, ser. 2, vol. 13, p. 269.

is made of a visit to the cañon, and it is implied that no such visit ok place: it is there stated that the pieces "were brought from a valley a small mountain-chain about forty miles south-east of Tucsan (*sic*), st of the road leading to Tuvaca (*sic*). In this valley, fragments similar those seen and of various sizes *were said to be* abundant. From the currence of this metal, the valley was called *Canada de Hierro* or *Iron lley*. Silver mines of great richness are very numerous in that inity: the metal occurs as sulphuret, with galena and blende, and also the native form."

3. Did Le Conte really visit the original site of the iron, or is he rely recording hearsay statements? By the following considerations are led to infer that his oral statement was initially mis-reported, and at no visit was made by him to the *Iron Valley*.

Le Conte was informally attached to Major Emory's party,[1] which was gaged in the survey of the western part of the boundary between the ited States and Mexico, and he spent eighteen months in California. eing that he was "passing through" Tucson in February 1851, and at he attended the meeting at Albany in August of the same year, it ems certain that his information about the iron was got during his rney home from California.[2] His stay at Tucson would thus probably t only a few hours; and if it had been otherwise he would have been le, by continued appeal, to overcome the indolence of the blacksmiths, d to get the fragments he desired. It is extremely improbable that an tomologist would have turned aside from his route many miles merely to the masses *in situ*: he must have had less curious companions who uld have objected to the delay: while a journey without an escort as fence from the Indians was then extremely dangerous. And if he had ntured so far out of the track he would not have returned without curing an illustrative specimen, and would have given a description of e mode of occurrence and the distribution through the valley. As a tter of fact his reference to the Tucson iron was only a casual one, de after hearing Professor Shepard read a paper relative to a meteoric ne which had fallen at Deal in New Jersey more than twenty years ore.

We may thus conclude that the later was the more correct version of Conte's original statement, and that he was merely recording ormation given to him at Tucson.

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[1] *Smithsonian Report for* 1851, p. 53.

[2] *Amer. Jour. Sci.*, 1854, ser. 2, vol. 18, p. 369.

Bartlett.

4. A year later, in July 1852, the two large masses were seen at Tucson by John Russell Bartlett,[1] then the United States Commissioner for the delimitation of the United States and Mexican frontier.

One, a ring-shaped mass, of which he gives a figure, was in use as an anvil in the blacksmith's shop. He writes as follows :—"It was found about 20 miles distant towards Tubac, and about 8 miles from the road, where we were told are many larger masses. There is another mass within the garrison grounds, of which I did not take a sketch. With much labour Dr. Webb broke off a fragment of this meteorite for the purpose of analysis."

Parke and Shepard.

5. In November 1854,[2] Professor Shepard gave a description of some small fragments, the largest not more than a quarter of an ounce in weight, which had been sent by Lieutenant John G. Parke, of the United States Topographical Engineers, on his return from Sonora. Parke had just been engaged in the survey for a railroad across the continent, and had chipped off the fragments while at Tucson in February 1854 : he was told that there were three masses, though only the two larger ones were seen by him. According to information supplied by Parke " they were found in a cañada of the Santa Rita Mountain, about 25 or 30 miles to the south of Tucson. Two of them were shown to us by the Commandante, both being used as anvils. One lies within the *presidio*, and is of a very peculiar form, being annular and somewhat like a seal-ring of huge proportions. Its exterior diameter is about 3½ feet : its interior about 2 feet. It weighs nearly 1,200 lbs. The other piece is in front of the Alcalde's house. It weighs about 1,000 lbs. and has an elongated prismatic form, serving well the purposes of an anvil. It is partially buried in the soil, but has two feet of its length projecting above the ground. The Alcalde and Commandante would not consent to our removing the masses, even if we had had the means."

The position of the Sierra de la Santa Rita is shown in the map[3] ac

[1] Personal Narrative of Explorations and Incidents in Texas, New Mexico California, Sonora and Chihuahua. New York, 1854, vol. 2, p. 297.

[2] *Amer. Jour. Sci.*, 1854, ser. 2, vol. 18, p. 369. Reports of Explorations and Surveys for a railroad from the Mississippi River to the Pacific Ocean: (Senate Documents): 1855, vol. 2, containing *inter alia* a report by J. G. Parke on Explorations between Doña Ana and Pimas Villages, p. 7.

[3] Reports of Explorations, &c. 1861; vol. 11.

ompanying the report of the survey made by Parke; it is on the eastern ide of the road, and north of Tubac.

Lawrence Smith.

6. Others of the fragments were sent by Parke to Professor Lawrence Smith,[1] and were analysed by him. The historical particulars given by Smith are quoted from information sent to him by Bartlett, and are identical with those published shortly afterwards in Bartlett's work.

Genth.

7. In April 1855[2] Dr. F. A. Genth, of Philadelphia, gave the results f analysis of some pieces of a specimen of the Tucson iron: the specimen ad been presented to the collection of the Academy of Natural Sciences of Philadelphia by Dr. Heermann. Though Dr. Genth gave no history of he specimen, there can be no doubt that it was one of the fragments eferred to by Parke, for Dr. A. L. Heermann[3] was the naturalist attached o that section of the Survey of the Pacific Railroad Route, on which Parke was engaged, and both were at Tucson together.

Michler.

8. The Tucson iron was seen by Lieutenant Michler[4] during a visit nade in June 1855: he merely states that "a fine specimen of meteoric con brought from the Santa Rica is to be seen at Tucson, and is used as blacksmith's anvil. It is massive and quite malleable." Michler, who lso belonged to the United States Topographical Engineers, was in harge of a surveying party under Emory, the successor of Bartlett, in onnection with the United States and Mexican boundary: his party was ncamped close to Tucson for nearly a month, and during that time eceived every attention and civility from Captain Garcia, who commanded he place. According to Michler, Tucson was then "inhabited by a few Mexican troops and their families, together with some tame Apache ndians. It is very prettily situated in a fine fertile valley at the base of he Sierra de Santa Catarina." From Tucson Michler went on to Los Nogales, sixty-nine miles to the south of it: "the road lay in the valley of

[1] *Amer. Jour. Sci.*, 1855, ser. 2, vol. 19, p. 161. (The greater part was read before the Amer. Assoc. Adv. of Sci. in April 1854.)

[2] *Proc. Ac. Nat. Sc. Phil.*, 1856, vol. 7, p. 317.

[3] *Ibid.*, p. 129; *Smithsonian Report for* 1854, p. 84.

[4] *Rep. of the U.S. and Mex. Bound. Sur.* (W. H. Emory), 1857, vol. 1, part 1, p. 18.

the Santa Cruz as far as the Rancho de las Calabazas between high mountains. On the east are the Santa Catarina, with its top covered with lofty pines, and the Santa Rita rich in minerals: and on the west are the Sierra Rica and the Sierra Atacosa." Calabazas is shown on the maps as on the side of Tubac more remote from Tucson: the distance by road from Tucson to Tubac is 48½ miles, from Tubac to Calabazas 13 miles.

Comparison of the above statements.

9. Owing to the surveys of the Mexican boundary and Pacific Railroad Route, the masses of iron at Tucson were thus seen and noticed within the short space of the four years, 1851-55, by Le Conte, Bartlett, Parke and Michler, but the original site was visited by none of them: their information as to its position is hearsay, and was doubtless communicated in turn to each of them, either by the Mexican Commandante or the Tucson blacksmiths: their statements are in all probability merely different versions of a single original. According to their various accounts the site is about 40 miles south-east of Tucson, and east of the road leading to Tuvaca (Le Conte): about 20 miles distant towards Tubac and about 8 miles from the road (Bartlett): about 25 to 30 miles south of Tucson in the Santa Rita Mountain (Parke): in the Santa Rica (Michler).

10. (1) All these statements agree in placing the site to the south of Tucson: (2) the three which specify the distance agree tolerably well with each other: (3) as according to Michler the Santa Rita is east of the road leading to Tubac, the only two which specify the side of the road agree in making it east (Le Conte and Parke): (4) the only disagreement is thus presented by Michler's statement that the iron was brought from the Santa Rica, for Sierra Rica is said by him to be on the west of this road. It will be conceded, however, that Rica is here a misprint for Rita: the two words appear close together in Michler's report, rendering such a misprint easy; this view is confirmed by the remark that Michler in the preceding sentence mentions, not Santa Rica, but Sierra Rica and Santa Rita: indeed the association of the words Santa and Rica (Holiness and Riches) is an unlikely one, while that of Santa and Rita is not uncommon. Further we may add that Michler speaks of Santa Rita as being rich in minerals, which accords with the character given to the locality of the cañon in the second version of Le Conte's statement.

11. We infer that in the years 1851-5 it was stated by the Mexican Commander of the fort at Tucson that the masses had been brought from a cañon in the Santa Rita, that the cañon was reached by travelling along the road from Tucson towards Tubac for a distance of 20 or 30 miles, and

y then turning off in an easterly direction for about 8 miles: further, nat the district was rich in silver minerals.

Irwin and Ainsa.

12. When the survey was concluded (1856) the boundary between the Jnited States and Mexico was transferred about seventy miles to the south f Tucson, and the town passed into the possession of the United States. Soon afterwards, in 1857, Dr. B. J. D. Irwin, Surgeon in the United States Army, who was stationed at Fort Buchanan, south of Tucson, ound the annular mass in one of the by-streets half buried in the earth; nd, no person claiming it, he publicly announced that he took (nominal) ossession of it with the intention of forwarding it to the Smithsonian nstitution. In 1860 the mass was sent, by the agency of Mr. Agustin Ainsa as far as Hermosillo, and later to Guaymas, a port of Sonora in the Gulf of California: in 1863 it was taken to San Francisco by Jesus M. Ainsa, and thence by Santiago Ainsa to the Smithsonian Institution at Washington by way of the Isthmus of Panama.

In a letter dated Sept. 5, 1863, sent to Mr. Henry, the Secretary of the Smithsonian Institution, Dr. Irwin[1] says:—"The only history I can give on is a vague one, as there is no written record of its advent in Tucson. The old inhabitants of that place all agree that it was brought thence from the Santa Catarina mountains, which lie to the north of Tucson, about midway between the Rio San Pedro and that town. It was brought in by the military stationed at the old *presidio*, where it remained until after the withdrawal of the Spanish garrison. It was then taken into town, set up on end, and used as a kind of public anvil for the use of the inhabitants. The smaller one was used in a blacksmith's forge for similar purposes." "The people of Tucson all agree that a shower of these meteorites fell in the Santa Catarina mountains some two hundred years ago, and I have been told that there were plenty of them remaining in the mountains. I never was in the immediate portion of the mountain-range where they report the specimens are to be found, so I cannot vouch for the correctness of their reports."

13. In another letter, dated August 26, 1863, sent likewise to Mr. Henry in response to an inquiry for information, Mr. Santiago Ainsa makes the following statements[2]:—"The history of this aerolite we have from our grandmother, Doña Ana Anza de Islas, daughter of Don Juan Bautista Anza, our great-grandfather. The Jesuit missionaries had the

[1] *Smithsonian Report for* 1863, p. 85. [2] *Ibid.*, p. 86.

earliest knowledge of this curiosity. There were various theories entertained about it; but it was generally believed to proceed from some iron-mine in the vicinity, which belief holds to this day in Sonora. In an expedition made by Don Juan Bautista Anza, then 'Gran Capitan de las Provincias del Occidente,' about the year 1735, to the country about Tucson, he was induced to visit the aerolite, and he undertook the work of transporting it to Spain. The place where it was found is called *Sierra de la Madera*, on a spot called *Los Muchadios*. Through the want of proper means and the bad state of the roads (having to carry it to San Blas, then the nearest port of entry) the work of transportation was given up, and they were satisfied to take it as far as Tucson."

14. In another part of the same Report[1] the name of the place is given by the Secretary, on the basis of Mr. Ainsa's letter, as *Los Muchaches*, in the *Sierra Madre*. As both statements are founded on the same letter, one or other or both of the words *Muchaches* and *Muchadios* must be the result of an error of printing, and inspection of the written words makes it clear that the variation could very easily arise in such a way: as *Muchadios* is not given in the Spanish dictionary, and *Muchachos* is the ordinary Spanish word for "boys," and as the names of Mexican localities have generally a simple Spanish interpretation, it is most satisfactory to regard both as misprints, and to take the *ch* of one version and the *os* of the other, thus adopting *Los Muchachos* as the correct spelling. On the other hand *Sierra Madre* is probably a misinterpretation of *Sierra de la Madera*: it is clearly not a mere misprint. Sierra Madre (or Mother Range) is the name given to one of the principal mountain-ranges, extending for hundreds of miles through Mexico and the United States: and in his interpretation of the Ainsa letter, Mr. Henry would appear to have taken the unknown name *Sierra de la Madera* to be merely another mode of writing *Sierra Madre*. Such a term would be too wide in its signification to have had any utility in the indication of a locality. But there is a common Spanish word *Madera* meaning *timber*: so that *Sierra de la Madera* might be a name given to any well-timbered mountain-range. That such a name would, up to 1855 at least, be peculiarly appropriate to the range on the east of the road leading from Tucson to Tubac is evident from the description given by Michler:—"On the east are the Santa Catarina, with its top covered with lofty pines, and the Santa Rita rich in minerals." In 1777, according to the Tucson archives,[2] there was an abundance of excellent pine in the Sierra de Santa Rita itself.

[1] *Ibid.* p. 55.

[2] *Reports of Explorations and Surveys, &c.*, 1857, vol. 7, appendix C.

15. This view is fully confirmed by a statement read by Professor Whitney[1] at San Francisco on July 20, 1863. He quotes a memorandum furnished by "Mr. James M. Ainsa," which, though identical in its general information with the letter dated August 26, 1863, sent by Mr. Ainsa direct to Mr. Henry, is so far distinct from it as to be an undoubtedly independent document. *Los Muchachos* is not mentioned at all, but the name of the mountain-range appears as *Sierra de la Madera*.

Comparison with the previous statements.

16. *Sierra de la Madera* is not mentioned on any accessible map, and Ainsa himself gives no information as to whether the site is north or south of Tucson. Still his letter would indirectly suggest that the place is to the north of Tucson, since he states that the iron was being transported to the port of San Blas, and therefore southward. Irwin, for his part, directly states that the masses were brought from the north of Tucson.

The only explanation which will bring into harmony these two statements and that which has reached us through Le Conte, Bartlett, Parke and Michler, seems to be the following:—As regards Ainsa's statement: the transportation to San Blas was a matter of difficulty, so much so that it was eventually abandoned; hence the masses may have been found to the south of Tucson, transported to the Tucson and Tubac road, and afterwards along it in the direction opposite to that of San Blas, either when the idea of transport had been finally given up, or when it was decided to wait for better means of carriage; the masses in such case being taken northwards and preserved in the neighbouring *presidio* of Tucson. As for Dr. Irwin, a glance at the wording of his statement makes it probable that he was merely told by the inhabitants of Tucson that the masses had been brought from the Santa Catarina mountains, and that he himself added the information that the mountains are to the north of Tucson, about midway between the Rio San Pedro and that town. In fact the only Sierra de Santa Catarina mentioned in various maps is in the position thus indicated by Irwin. But a reference to Michler's report shows that, at least in 1855, the term Sierra de Santa Catarina was by some persons differently applied: Michler speaks of Tucson as being "very prettily situated in a fine fertile valley at the base of the Sierra de Santa Catarina," and in describing his journey from Tucson to Tubac says that "the road lay in the valley of the Santa Cruz between high mountains. On the east are the Santa Catarina and the Santa Rita."

[1] *Proc. Calif. Ac. Nat. Sc.*, 1863, vol. 3, part 1, p. 48.

Further, on more than one map the Sierra de Santa Catarina is marked as extending from the north side of Tucson to the south of Tubac.[1] The information given by Irwin is thus not inconsistent with the former statements, if we may assume that he had misapprehended what was intended to be meant by the term "Santa Catarina mountains."

Velasco.

17. The correctness of the above arguments is established by the following paragraph from a work published by Velasco[2] in the year 1850, a date antecedent to that of any of the publications above referred to; as Velasco's work is not easily accessible the paragraph is also given in the original Spanish :—[3]

"Between the presidio of Tucson and Tubac is a mountain-range called Sierra de la Madera and (a pass called) Puerto de Los Muchachos. In it are seen enormous masses of native iron, and many have rolled to the foot of the said sierra. One of the masses of a moderate size was transported to Tucson, and has stood for many years in the *plaza* (square) of the said presidio."

Scarcely a single map gives any information relative to the region adjacent to Tucson and Tubac: but in Stieler's Atlas the southern part of the range on the eastern side of the road between Tucson and Tubac is designated Sierra de la Santa Rita, and a pass running in an easterly direction at the north side of this sierra is marked as Puerto de los Muchachos. The map is based on the observations of Captain A. W. Whipple, of the United States and Mexican Boundary Commission: he travelled through the Puerto de Los Muchachos in 1853, and his route is indicated in Parke's map already referred to.

Whitney.

18. Professor Whitney of San Francisco (who cites an English translation of Velasco's work, published in 1861), summarising the contents of various letters sent to him, said on February 19, 1866[4] :—

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[1] e.g. *Nueva Mapa de Mexico*, 1866. Pub. por Colton & Co., New York, U.S.A.

[2] *Noticias Estadisticas del Estado de Sonora, &c.* By Jose Francisco Velasco. Mexico, 1850, p. 221.

[3] "Entre el presidio del Tucson y Tubac, hay una sierra que llaman de la Madera y puerto de los Muchachos. En ella se ven masas enormes de fierro vírgen, y muchas están rodadas al pié de dicha sierra. De aquellas masas de fierro llevaron una mediana al Tucson, la cual hace muchos años ecsiste tirada en la plaza de dicho presidio."

[4] *Proc. Calif. Ac. Nat. Sc.*, 1866, vol. 3, part 3, p. 241.

"It is stated by several persons who have visited southern Arizona, among whom Dr. Horn may especially be mentioned, that it is universally believed, and vouched for by apparently trustworthy explorers, that there are many large masses of iron near the summit of the range next east of Tucson."

19. One odd conclusion follows from the above; namely, that Dr. Irwin was actually stationed in the immediate neighbourhood of the true locality: for Fort Buchanan is on the eastern side of the Tucson and Tubac road, and about 30 miles from Tucson: indeed, it appears to be approached from the Tucson and Tubac road through the Puerto de los Muchachos itself. Hence it would seem that he was only prevented from finding any remaining masses by an unlucky misapprehension of the term "Santa Catarina mountains."

Removal of the masses from Tucson.

20. We have already seen that one of the two large masses, the ring-shaped one figured by Bartlett, was removed from Tucson in 1860, and deposited in the hall of the Smithsonian Institution at Washington in 1863. The other was taken possession of by General James H. Carleton, and sent to San Francisco in the year 1862:[1] Carleton was in command of the Column from California; he presented the mass to the City of San Francisco as a memento of the march of his Column, and asked that it might be "placed upon the Plaza, there to remain for the inspection of the people and for examination by the youth of the city for ever." It was, however, deemed advisable to keep the specimen in a safer and drier place, and it is now in the hall of the Pioneer Society.[2] A figure of the mass, prepared from a photograph sent to him by Professor Whitney, has been published by Haidinger[3].

Form and Dimensions.

21. The dimensions of the ring-shaped mass now at Washington are given by Whitney[4] as follows:—

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[1] *Proc. Calif. Ac. Nat. Sc.*, 1863, vol. 3, part 1, p. 33.
[2] *Mineral Resources of the United States for* 1883-4 (Williams), p. 290.
[3] *Sitz. Ak. Wien.*, 1863, vol. 48, part 2, p. 303.
[4] *Proc. Calif. Ac. Nat. Sci.*, 1863, vol. 3, part 1, p. 49.

"Greatest exterior diameter	49 inches.
Least exterior diameter	38 inches.
Greatest width of central opening	26½ inches.
Least width of central opening	23 inches.
Greatest thickness at right angles to plane of ring... ...	10 inches.
Width of thickest part of the ring	17½ inches.
Width of narrowest part	2¾ inches.
Weight estimated by Ainsa as	1,600 lbs."
An inscription on the specimen now gives the weight as ...	1,400 lbs.

The form of the mass now at San Francisco is described by Whitney as follows:—

"Shape irregular, but in general that of a flattened elongated slab; length, 49 inches; average breadth, 18 inches; thickness varying from 2 to 5 inches. Weight, 632 lbs."

Supposed difference in the characters of the masses.

22. There has been a certain amount of discussion as to whether the two masses are not essentially different in their characters. By a curious coincidence they were both in San Francisco at the same time, and Professor Whitney had the opportunity of directly comparing them. He reports as follows:[1]—

"On examining with a magnifying glass a fractured surface of the ring-shaped iron, it was seen at once to be different in composition from the Carleton meteoric iron, and my conjecture that Professor Smith was mistaken in supposing that he analysed a fragment from the mass figured by Mr. Bartlett was confirmed. It is now almost certain that Messrs. Brush and Smith did analyse fragments of the same mass (the Carleton one)."

23. Though there may still be some doubt as to which mass Professor Smith's fragments were taken from, the doubts which had arisen in the mind of Whitney were the result of a misunderstanding. Smith reproduced the figure of the ring-shaped mass as sketched by Bartlett, who had furnished him with information relative to the iron before the actual publication of the "Personal Narrative": hence Whitney inferred[2] that Smith's analysis was made on the fragments mentioned in Bartlett's work, and those appear to have been got by Dr. Webb from the second mass

[1] *Ibid.*, p. 49.
[2] *Ibid.*, p. 34.

he Carleton one) in the garrison grounds, though Bartlett's statement wanting in precision. But a reference to Smith's paper shows that this as not the case: the fragments were obtained, not from Webb or artlett, but from Parke, who in the report sent to Professor Shepard iled to indicate from which mass they had been taken. Lawrence mith appears to have been under the impression that they were taken om the ring-shaped mass, and it is possible that he may have ceived direct information from Parke to that effect.

24. Baron von Richthofen, who was in San Francisco at the time that e ring-shaped mass was in the city, also supported the view of Whitney in letter published by Haidinger:[1]—"Brush calls attention to the striking greement of his analysis of the Carleton iron with an analysis made by awrence Smith of an iron from Tucson. A comparison of the two eteorites leaves however scarcely a doubt that Bartlett knew both, and at both analyses have been made on pieces of the Carleton mass. The ng-shaped mass has so different a mineral composition that we must ffer an important difference in the chemical constituents. Schreibersite ed olivine are not observable in it, while on the other hand there is large number of white and apparently crystalline grains which look like a spar. Whitney and I came to the conviction that they may be enorthite."

25. After examination of the etched faces, Brezina says:—"The nsa iron presents a certain similarity with the Carleton iron, yet not fficient to allow of their being placed together without further vestigation."[2]

The masses are products of a single meteor.

26. With regard to this point, the above history of the Tucson iron is fficient to establish beyond reasonable doubt that both masses have been ought to Tucson from the same valley, and have resulted from a single eteor. It must be remembered that the observations of Whitney and ichthofen were merely preliminary ones, made on rough fractured rfaces of the masses, and that the fragment of the annular mass ailable for examination by Brezina weighed only 8 grams, and had obably been more or less hammered at Tucson during its removal from e block. In the British Museum there are now good fragments of th masses, one of them sent from San Francisco many years ago through

[1] *Sitz. Wien. Ak.*, 1863, vol. 48, part 2, p. 306.

[2] *Die Meteoriten-sammlung in Wien*, 1885, p. 71.

Professor Whitney, and the other from Washington more recently through Dr. F. W. Clarke. They have been lately polished, and the identity of their essential characters is now manifest: and this identity is one of characters extremely rare in meteoric irons. Masses of iron, like those of Krasnojarsk and Breitenbach, having numerous disconnected pores filled with stony matter, are not frequent among meteorites; but in the case of both of the Tucson masses not only is this a characteristic feature, but in each of them the grains of included silicate are on a much smaller scale than those included in other irons of the same type. The included grains are crystalline, and are identical in aspect. One of the sections is 75 mm. long, and has a width increasing from zero to 50 mm.; the other is 40 mm. long and has a width varying between 44 and 70 mm. Most of the included grains, thousands in number, are only one or two-tenths of a millimeter in diameter, but there are a few of which the thickness reaches a millimeter: their distribution is generally irregular, but in one part of each section they are arranged in parallel slightly curved lines, and are elongated in the same direction. Irregular fields, sometimes 5 or even 8 mm. in diameter, appear at first sight to be free from enclosures, but the presence of microscopic grains is indicated by the punctuation which becomes visible when the polished face is examined with the aid of a lens. No Widmanstätten figures were formed when the polished faces were etched with bromine-water, but over the whole extent of both sections there became visible an irregular network of yellow metallic lines, resembling tænite or schreibersite, and round each enclosure, large or small, was seen a linear margin of the same material.[1]

As it is impracticable to give a special name to every separate mass of a meteoritic fall, the names of Irwin-Ainsa iron, Ainsa iron, Signet iron, Tucson-Ainsa iron, Carleton iron and Tucson-Carleton iron may therefore be advantageously dropped from scientific literature, and the masses be designated simply as Tucson iron.

27. It is thus of trivial importance whether the fragments sent to Shepard, Genth and Smith, were got from the one or the other mass, for different parts of the same mass may present as great variations of mineral constitution as distinct masses belonging to the same fall: the fragment sent to Brush was taken from the mass now at San Francisco.

Specific Gravity.

28. The specific gravity, according to Shepard, is 6·66: according to Smith 6·52, 6·91, 7·13 for three different fragments; his chemical examination was made on the last, which appeared to be the most compact

[1] See also G. Rose's *Beschreibung der Meteoriten zu Berlin;* 1864, p. 150.

nd free from stony particles: the specific gravity of a fragment, as etermined by Brush, was 7·29.

Chemical analyses made by Shepard, Smith, Genth, and Brush.

29. The examinations made by Shepard, Smith, Genth, and Brush, ave some doubt as to the true nature of the stony matter.

1. After the solution of the metallic portion in *aqua regia*, Shepard ound a residue consisting partly of a mealy powder and partly of small voidal grains, some of them milk-white, some perfectly limpid, others ilky on one side and limpid on the other, and therefore all probably elonging to a single mineral species: he was led to regard the mealy owder as of the same nature as the ovoidal grains, and to infer from eneral resemblance that the silicate was likely to be identical with that of e Bishopville stone to which he had given the name of *chladnite* (but hich is now known as enstatite).

2. Smith separated some few particles of the stony matter mechanically, nd from its general appearance when seen with a lens, and from the easy lubility in acids when it yielded silica and magnesia, decided that it was doubtedly *olivine*. Like Shepard he points out that some of the licate is in a pulverulent condition.

3. Genth reports as follows:—" On evaporation of the solution by tric acid, and subsequent moistening of the dry mass by hydrochloric id, all the substances were taken up excepting a small residue of liceous matter. This partly dissolved on boiling with carbonate of soda, aving a residue which I took for a felspathic mineral: the quantity btained, however, was too small for further examination; the small uantities of alkalies, lime and alumina (in the bulk-analysis) speak in vour of this view, and indicate that the residue insoluble in carbonate of da is *labradorite*, a mineral which is partly decomposed by acids. The ica, soluble in carbonate of soda, results undoubtedly from the composition of *olivine*.'

4. Brush, after examination of the residue left behind when the metallic rtion had been dissolved out by nitric acid, gave a description of the voidal grains which perfectly agrees with that of Shepard, but remarked at their behaviour before the blowpipe very much resembled that of *ivine*. He further reported as follows:—

" For the quantitative examination a fragment weighing 4·3767 grams as treated with *aqua regia*, and after solution of the iron the whole was vaporated; on approaching dryness, gelatinous silica separated, showing at the silicate had been, partially at least, decomposed by the acid.

After heating until the silica was rendered insoluble, it was repeatedly treated with acid and evaporated, so as to insure the oxidation of all the schreibersite; and finally the soluble part was taken up with hydrochloric acid, and on dilution separated from the silica and insoluble residue. The insoluble residue, containing free silica and undecomposed silicate, was perfectly white and free from all traces of schreibersite. It weighed 0·1855 grm. It was fused with carbonate of soda, and the silica and base determined in the usual manner. It yielded :—

SiO_2	...	...	...	0·1590
FeO	...	...	...	0·0054
Al_2O_3	...	...	...	minute trace
CaO	...	...	...	0·0028
MgO	...	...	...	0·0168
				0·1840."

Analytical results.

30. It will be convenient to insert here the following complete analytical results of Smith, Brush, and Genth :—

	Smith.	Genth.			Brush.
		I.	II.	III.	
Fe	85·54	83·47	not est.	83·64	81·65
Ni	8·55	9·44	8·69	9·85	9·17
Co	0·61	0·42	0·37		0·44
Cu	0·03	0·008	not est.	not est.	0·08
P	0·12	0·10	not est.	0·15	0·49
Al_2O_3	trace	trace	trace	trace	trace
CaO	...	0·46	0·55	not est.	1·16
MgO	2·04	2·59	2·03	2·15	2·43
Na_2O	...	not est.	not est.	0·174	...
K_2O	...	not est.	not est.	0·098	...
Cr_2O_3	0·21	not est.	not est.	0·50	...
SiO_2	3·02	2·89	not est.	4·17	3·63
Labradorite (?)	...	1·05	not est.		...

Deductions from the analytical results.

§ 31. Whatever the true nature of the stony matter, the grains included in the iron are obviously very different in size; and unless the action of the acid has been very prolonged the larger grains, whatever their nature, may escape complete decomposition: hence an opinion that the residual silicate is more difficultly decomposed than olivine, based solely on the incomplete decomposition of the stony matter by the acid, must in any case be received with caution.

a. "The general resemblance" and the "presence of decided traces of magnesia in the acid solution," relied upon by Shepard as supporting the view that the stony matter is possibly identical with that of the Bishopville stone, are obviously characters of no great weight.

b. Smith considered the stony matter to be olivine: his experiments undoubtedly prove that the particles, separated by him mechanically, differed from the Bishopville silicate in being easily decomposed by acids: but he only proved the presence of magnesia and silica as constituents, and left it undecided whether more than one kind of stony material is included in the iron.

c. Genth inferred from his experiments that the stony matter consists largely of olivine, but that there is an appreciable proportion of a feldspathic material, probably labradorite. The first inference is based on the amount of silica set free through the action of the acid; the second on the presence of material undecomposed by the acid, and on the small quantities of alkalies, lime and alumina found in the acid solution. The presence of labradorite cannot, however, be regarded as established by him: in the first place, no evidence is adduced that the undecomposed material differs from that which has been decomposed; and in the second place, if the alkalies and lime found in the acid solution had been due to labradorite, they would have been accompanied by more than a trace of alumina.

d. In fact, Brush (who was probably unaware of Genth's analysis) came to the conclusion that the undecomposed silicate, obtained in the course of his own examination, was olivine. His analysis of the mixed silica and undecomposed silicate was imperfect in that a separation of the two substances was not made: still the numbers obtained are of value in deciding on the nature of the residue. The constituents are those of

either olivine or bronzite, and are not those of a felspar. If the substan be an olivine ($2R''O.SiO_2$), the amount of silica combined with the bas will be 0·0188, and the composition will be as follows :—

	Undecomposed Silicate.		Olivine of Fogo I. (Deville).[1]	Olivine of Imilac (von Kobell).[2]	Olivine of Krasnojarsk (Berzelius).[3]
	Determin'd Weights.	Percentage Composition.			
SiO_2 ...	[0·0188]	[42·92]	40·19	40·79	40·86
FeO ...	0·0054	12·33	15·27	12·10	11·72
MnO ...	...	...	2·27	...	0·43
CaO ...	0·0028	6·39	5·12	...	...
MgO ...	0·0168	38·36	35·70	47·05	47·35
Al_2O_3 ...	trace	trace	0·80	0·02	...
	[0·0438]	[100·00]	99·35	99·96	100·36

It must be remembered that according to this calculation the percenta composition of the undecomposed material is based on the analysis of on 0·0438 grams.

The similarity of the numbers thus obtained to those which characteri certain terrestrial and meteoritic olivines will be obvious from the abo table.

32. The bulk-analyses made by Smith, Genth and Brush, all indica that a basic silicate is present : the proportion of the lime and magnes to the silica is alone sufficient to prove the presence of a silicate mo basic than enstatite ; and as the stony matter certainly contains ferro oxide as well as lime and magnesia, the basicity of the stony matter considerable. Hence, we may take it that there is absolutely no dou that the stony matter consists very largely, at least, of olivine ; and th so far there is no valid proof of the presence of any other kind of silica

If there is only one kind of silicate (an olivine) present, its compositi can be determined from each of the bulk-analyses ; and the results oug to correspond with each other and with that deduced for the undecompos residue analysed by Brush.

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[1] *Zeitsch. d. deutsch. geol. Gesell.* 1853, vol. 5, p. 693.

[2] *Corresp. Bl. zool. min. Vereines in Regensburg*, 1851, p. 112.

[3] *Pogg. Ann.* 1834, vol. 33, p. 134.

The following results are obtained by calculation :—

		Smith.	Genth.	Brush.
SiO_2	...	34·87	36·58	35·94
MgO	...	23·56	28·61	24·06
FeO	...	[41·57]	[24·94]	[28·52]
CaO	...	—	6·46	11·48
Na_2O	...	—	2·15	—
K_2O	...	—	1·26	—
		100·00	100·00	100·00

The numbers differ considerably, but are deduced from analyses which evidently incomplete : in the analysis made by Brush the alkalies re probably not looked for, owing to the insufficiency of the material : same may be said of Lawrence Smith's analysis, with the addition that lime, also having escaped notice, has been either lost, or weighed along h the iron or magnesia.

Mineralogical interpretation of the analytical results.

33. It seemed that in the case of analyses made by such experienced mists as Lawrence Smith, Genth and Brush, it ought to be possible, withstanding the differences in their numerical results (§ 30), to find a neralogical interpretation which will agree with the analyses within the inary limits of experimental error: we have to remember that the coritic fragments are mixtures of different minerals, and that the portions of the latter may be more or less variable.

34. The following is offered as a satisfactory solution of this blem : —

a.) The meteorite is a mixture of nickel-iron, olivine, schreibersite and omite : the composition of the nickel-iron being :—

Iron	...	...	89·89
Nickel	...	...	9·58
Cobalt	...	...	0·49
Copper	...	...	0·04
			100·00

that of the olivine :—

		Oxygen.	
FeO	24·07	5·35	
MgO	27·37	10·85	
CaO	8·67	2·48	
Al_2O_3	trace	...	19·44
Na_2O	2·15	0·55	
K_2O	1·26	0·21	
SiO_2	36·48	...	19·44
	100·00		

The schreibersite and chromite, which are relatively small in quantity may be assumed to have the average composition indicated by the formul Fe_2 Ni P (Fe 55·53, Ni 29·09, P 15·38) and $FeO{\cdot}Cr_2O_3$ (FeO 32·1 Cr_2O_3 67·89).

(*b.*) The proportions of the mineral constituents vary throughout th masses: this is obvious to the unassisted eye, and the extent of the var ation is shown by the differences of specific gravity: for the fragmen analysed by Lawrence Smith and Brush, and the fragment I. analyse most completely by Genth, the proportions were as follows:—

	Smith.	Genth.	Brush.
Nickel-iron ...	90·64	90·03	86·24
Olivine ...	8·29	8·60	10·05
Schreibersite ...	0·77	0·64	3·18
Chromite ...	0·30	0·73	0·53
	100·00	100·00	100·00

35. The agreement of the calculated and observed results is shown the following tables:—

Lawrence Smith.

	Nickel-iron.	Olivine.	Schreibersite.	Chromite.	Total.	Calculated.	Observed.	Differences.
Fe	81·48	1·55	0·43	0·08	83·54	85·54	85·54	0
O	..	0·44	..	0·02	0·46	0·47	..	..
Ni	8·68	..	0·22	..	8·90	9·11	8·55	−0·56
Co	0·44	..	..	..	0·44	0·45	0·61	+0·16
Cu	0·04	..	..	..	0·04	0·04	0·03	− ·01
P	..	..	0·12	..	0·12	0·12	0·12	0
Cr_2O_3	..	..	..	0·20	0·20	0·21	0·21	0
MgO	..	2·27	..	..	2·27	2·33	2·04	− ·29
CaO	..	0·72	..	..	0·72	0·74	..	..
Na_2O	..	0·18	..	..	0·18	0·19	..	..
K_2O	..	0·10	..	..	0·10	0·10	..	..
SiO_2	..	3·03	..	..	3·03	3·10	3·02	− ·08
Total ..	90·64	8·29	0·77	0·30	100·00	102·40	..	..

GENTH.

	Nickel-iron.	Olivine.	Schreibersite.	Chromite.	Total.	Calculated.	Observed.	Differences.
Fe	80·93	1·42	0·35	0·18	82·88	83·47	83·47	0
O	..	0·40	..	0·05	0·45	0·45	..	..
Ni	8·62	..	0·19	..	8·81	8·87	9·44	+0·57
Co	0·44	..	..	..	0·44	0·44	0·42	— ·02
Cu	0·04	..	..	..	0·04	0·04	0·01	— ·03
P	..	..	0·10	..	0·10	0·10	0·10	0
Cr_2O_3	..	..	..	0·50	0·50	0·50	0·50	0
MgO	..	2·07	..	..	2·07	2·09	2·59	+ ·50
CaO	..	0·65	..	..	0·65	0·66	0·46	— ·20
Na_2O	..	0·16	..	..	0·16	0·16	0·17	+ ·01
K_2O	..	0·10	..	..	0·10	0·10	0·10	0
SiO_2	..	2·76	..	..	2·76	2·78	2·89	+ ·11
Undecomposed	..	1·04	..	..	1·04	1·05	1·05	0
Total ..	90·03	8·60	0·64	0·73	100·00	100·71	..	..

BRUSH.

	Nickel-iron.	Olivine.	Schreibersite.	Chromite.	Total.	Calculated.	Observed.	Differences.
Fe	77·52	1·88	1·77	0·13	81·30	81·65	81·65	0
O	..	0·54	..	0·04	0·58	0·58	..	..
Ni	8·26	..	0·93	..	9·19	9·23	9·17	—0·06
Co	0·42	..	..	..	0·42	0·42	0·44	+0·02
Cu	0·04	..	..	..	0·04	0·04	0·08	+0·04
P	..	..	0·48	..	0·48	0·48	0·49	+·01
Cr_2O_3	..	..	..	0·36	0·36	0·36	trace	..
MgO	..	2·75	..	..	2·75	2·76	2·43	— ·33
CaO	..	0·87	..	..	0·87	0·88	1·16	+ ·28
Na_2O	..	0·21	..	..	0·21	0·21	..	..
K_2O	..	0·13	..	..	0·13	0·13	..	..
SiO_2	..	3·67	..	..	3·67	3·69	3·63	— ·06
Total ..	86·24	10·05	3·18	0·53	100·00	100·42	..	..

(Since the whole fragment analysed by Brush weighed 4·3767 grams, the composition of the stony matter is based on the analysis of 0·4399 grams.)

Summary.

36. The differences in the statements of Le Conte, Bartlett, Parke, Michler, Irwin, and Ainsa, relative to the original site of the meteoritic masses of Tucson, are all such as might easily result from simple errors

of printing or interpretation : the masses have been known for centuries : they were found in a pass called *Los Muchachos*, which is between Tucson and Tubac, and is on the eastern side of the road : other masses of various sizes are said to be still in the pass. The results of the analyses made by Smith, Genth and Brush, show that, besides small proportions of schreibersite and chromite, there is a varying proportion (8 to 10 per cent.) of stony matter included in the nickel-iron : they are consistent with the stony matter being a lime-olivine, having approximately the per-centage composition FeO 24·07, MgO 27·37, CaO 8·67, Na_2O 2·15, K_2O 1·26, and SiO_2 36·48, and with the nickel-iron being composed of Fe 89·89, Ni 9·58, Co 0·49 and Cu 0·04.

Abstracts.

Passage between Granophyre and Gabbro.—At Pigeon Point, Minnesota, . S. Bayley has investigated certain fine-grained red eruptive rocks of id nature, which occur in close association with an olivine-gabbro. (*Amer. urn. Sci.*, (3) Vol. xxxvii., p. 55; 1889.) The red rocks comprise th even-grained and porphyritic types, and consist of two felspars, artz, chlorite, and several subordinate constituents. They are referred the "quartz-keratophyres" of Rosenbusch, the dominant felspar being anorthoclase of the composition shown in column I. (by W. F. Hillebrand). More interesting is the passage traceable in the field from these d rocks into the olivine-gabbro. This is illustrated by analyses of the o very different rocks and of intermediate varieties taken in order. ese are given in columns II., III., IV., V., VI.; II. being the granoyric acid rock named by the author quartz-keratophyre, and VI. the vine-gabbro.

	I.	II.	III.	IV.	V.	VI.
O_2 ...	65·00	72·42	57·98	57·88	50·69	49·88
O_3 ...	—	0·40	1·75	—	—	1·19
$_2O_3$ ...	18·22	13·04	13·58	—	—	18·55
$_3O_3$ ...	2·64	0·68	3·11	—	—	2·06
eO ...	—	2·49	8·68	—	—	8·37
nO ...	—	0·09	0·13	—	—	0·09
aO ...	1·06	0·66	2·01	4·68	7·94	9·72
:O ...	—	—	trace	—	—	trace
aO ...	—	0·15	0·04	—	—	0·02
gO ...	0·06	0·58	2·87	—	—	5·77
$_2O$ ...	4·18	4·97	3·44	—	—	0·68
$_2O$ ...	8·40	3·44	3·56	—	—	2·59
$_2O$ ...	—	trace	trace	—	—	—
$_2O$ ...	0·46	1·21	2·47	—	—	1·04
O_5 ...	—	0·20	0·29	—	—	0·16
...	—	—	—	—	—	trace
	100·02	100·33	99·91	—	—	100·12
. gr. ...	2·577 + 2·620		—	2·741	—	2·923

These figures bring out well the increase in lime and magnesia, and the decrease in silica and potash; and from the field-evidence the author ascribes the phenomena to a "mutual interfusion of the basic and acidic rocks at their points of contact." He compares the acid rocks of Pigeon Point with R. D. Irving's "augite-syenites" in the Keweenaw Series. [They also seem to compare pretty closely with rocks in the English Lake district, such as the Buttermere granophyre and the Eskdale granite. The passage described is further interesting with reference to the transition observed between granophyre and gabbro on Carrock Fell by Mr. Teall.]

A. H.

Beryllonite, a new mineral. E. S. Dana and H. L. Wells describe a new mineral from a granitic vein at Stoneham, Maine, U.S.A. It occurs in the form of imperfect rhombic crystals with numerous faces, and often twinned. There is a highly perfect basal cleavage, with less perfect pinacoidal cleavages. Hardness 5·5—6; sp. gr. 2·845; colourless to white, or slightly yellowish. The analysis agrees very closely with the formula $Na\,Be\,PO_4$. The optic axes lie in the plane parallel to *a*; and the acute bisectrix is normal to *c*. (*Amer. Journ. Sci.* (3), xxxvii., p. 23, 1889.)

A. H.

Edisonite; a fourth form of titanic acid. (?) W. E. Hidden has described from the Whistnant Gold Mine, Polk Co., N. Carolina, U.S.A. some crystal fragments which he regards as a new rhombic form of titanic acid. The mineral occurs associated with rutile, anatase, xenotime, monazite, &c. The only natural faces present were a prism (angle 140° 84′) and the basal pinacoid. As placed by Des Cloizeaux, to bring out a pseudo-tetragonal symmetry, these become macrodome and brachypinacoid. Other forms are given by three pairs of cleavage-directions. The hardness is 6; sp. gr. 4·285; lustre resinous to adamantine; colour bronze-yellow to golden-brown. A careful analysis by S. L. Penfield shows that only TiO_2 (Titanic Acid) is present. (*Amer. Journ. Sci.*, (3) vol. xxxvi., p. 272; 1888.)

Müggo however has subsequently described Rutile from Snarum (and probably also from the Urals) which has a similar cleavage, but is, without doubt, ordinary Rutile, having faces of separation nearly conciding with the pyramid $\frac{2}{3}$ P∞ {902}. (*Neues Jahrb.* 1889 (1), p. 231.) It is therefore, improbable that the mineral described by Des Cloizeaux is a new substance.

A. H.

Phonolite-pumice from the Laacher See district.—K. Busz has investigated the characters and mutual relations of several rocks in the neighbourhood of the Laacher See. (*Sitzungsb. d. niederrhein. Gesellsch.*, 11th November, 1889.) South-east of the foot of the Olbrück hill occurs a loose pale-brown tuff, consisting of fragments of pumice about the size of a pea, with pieces of Devonian slate, grains of quartz, and crystals of leucite. It encloses numerous blocks of the well-known Olbrück rock (the so-called 'nosean-phonolite,' &c.). The pumice consists largely of leucite-crystals, often rounded, the larger ones showing twin-striation. These are imbedded in a colourless or yellowish glass with augite, magnetite, and sphene. Nepheline crystals are found, and more sparingly decomposed nosean. The pumice fragments lie in a light brown ground, consisting chiefly of comminuted pumice with crystals of leucite, augite, nosean, sanidine, and biotite, and fragments of slate. This tuff compares well with the Olbrück rock, and is held to have had a common origin with it. Similar relations between pumice and phonolite are found in other localities in the district. A pumice from a road-cutting near Bell differs from the others in that the prominent white crystals are not leucite, but nosean in rhombic dodecahedra. Large crystals of sanidine occur with it. A. H.

New forms on Native Sulphur.—K. Busz (*ibid.*) describes crystals of sulphur occurring with galena from Bassick, U.S.A. They show as many as twenty-one different forms on one crystal. The pyramids (335) and (337) are observed for the first time. The pyramid (119), found by Zepharovich on sulphur from Swoszowice, is constantly present here.

A. H.

Monazite as a rock-forming mineral.—O. A. Derby records monazite, the phosphate of cerium, lanthanum, and didymium, as a wide-spread accessory constituent in the gneisses, granites, and syenites of Brazil (*Amer. Journ. Sci.* (3), vol. xxxvii., p. 109; 1889). It was first discovered in the sea and river-sands of the district, and separated by washing: [sp. gr. = 5·2]. Subsequently it was obtained by the same method from the rocks *in situ*. The residue is a sand consisting of yellow grains of monazite and white zircons. One granitite yielded 0·07 *per cent.* A. H.

Strontianite and Celestine.—A Cathrein (*Zeitschr. f. Kryst.*, vol. xiv., p. 366) describes calciostrontianite (emmonite) from Brixlegg in the

Tyrol, where it occurs in spherical aggregates of small imperfectly-formed crystals of a yellowish colour, associated with barytes. An analysis gives

$$SrCO_3\ 86{\cdot}89.\quad CaCO_3\ 13{\cdot}14\ ;$$

closely agreeing with Thomson's 'emmonite' from Massachusetts.

J. Beckenkamp *(ibid.* p. 66) describes a strontianite from the Kaiserstuhl, in Baden, which yielded 4·91 *per cent.* of CaO and 63·94 of SrO, corresponding to

$$SrCO_3\ 91{\cdot}12,\quad CaCO_3\ 8{\cdot}77.$$

This mineral occurs in bunches of needle-like crystals, and also in minute crystals having a remarkable tetrahedron-like development. Celestine also occurs.

A. H. Chester *(Amer. Jour. Sci.*, (3) vol. xxxiii., p. 284) gives an analysis by F. J. Cairns of pale-red celestine from Lairdsville, near Hamilton College, which contains

$$SrSO_4\ 84{\cdot}09\ ;\ BaSO_4\ 10{\cdot}05\ ;\ CaSO_4\ 4{\cdot}86.$$

G. Bettanini *(Riv. Sci.-Indust. di Firenze*, 1887) and G. B. Negri *(Riv. Min. e Crist. Ital.*, 1887) have made crystallographic studies of celestine crystals from Montecchio Maggiore. The former calculates the axial ratios by the method of least squares to be

$$a : b : c = 0{\cdot}77739 : 1{\cdot}00000 : 1{\cdot}27354.$$

The latter finds

$$a : b : c = 0{\cdot}77926 : 1{\cdot}00000 : 1{\cdot}28282.$$

A. H.

Rock-forming Allanite and Epidote.—In recent years, allanite or orthite has become recognised as a wide-spread primary accessory in many igneous rocks, especially in North America. Parallel intergrowths of this mineral with epidote, the allanite commonly forming the core of the compound crystal, have also been noticed, and were recorded by W. H. Hobbs as a frequent occurrence in the porphyritic granite of Ilchester, Md. (*Johns Hopkins Univ. Circ.*, No. 65; 1888). This author has more recently given a detailed account of the minerals *(Amer. Journ. Sci.* (3), vol. xxxviii., p. 223; 1889). The epidote is in yellow columnar crystals, one to three mm. long, with a brown kernel of allanite. The latter is idiomorphic, and when the epidote also shows crystal faces, the parallelism of growth is evident. The forms observed are *M* (001), *r* ($\bar{1}01$), and *T* (100). The allanite has high refractive index, feeble

birefringence, and strong dispersion : its pleochroism is marked ; α, light yellowish-brown ; β, chestnut-brown ; γ, dark greenish-brown ; absorption $\gamma > \beta > \alpha$, as in epidote. The epidote gave ; α, nearly colourless ; β, light straw-yellow ; γ, siskin-green. An analysis by W. F. Hillebrand agrees closely with Ludwig's Untersulzbach epidote, and gives very closely the formula $2\ H_2Ca_4Al_6Si_6O_{26} + H_2Ca_4Fe_6Si_6O_{26}$.

Lacroix has described precisely similar instances of intergrowth of allanite and epidote in pyroxene-amphibole-gneiss from Finisterre, pyroxene-wernerite-gneiss from the Lower Austrian Waldviertel, and wernerite-gneiss from Odegarden in Norway (*Bull. Soc. Franç. Min.* Vol. xii., pp. 138, 157, 210 ; 1889.) He considers both allanite and epidote primary minerals. Hobbs states that the allanite in the Ilchester rock is one of the earliest separations from the magma, but is inclined to favour a metamorphic origin for the epidote, which is often without crystal boundaries. A. H.

A Mica-peridotite from the Harz.—Besides the two chief gabbro masses of the Harz occurs a smaller one to the north-east, in the upper part of the Kaltenthal near Harzburg. Here, as elsewhere, there is a tendency in these basic rocks to separate into more and less basic portions with a definite strike. The typical norite has 49·23 *per cent.* of silica, the olivine-gabbro 46·43, the well-known 'schillerfels' or bastite-serpentine-rock (Harzburgite of Rosenbusch) 42·36. To these M. Koch (*Zeitsch. deutsch. geol. Gesell.* Vol. xli., p. 163 ; 1889) adds an ultrabasic rock from Kaltenthal, with the following analysis by Hampe :—

SiO_2	34·98
TiO_2	5·18
Al_2O_3	10·80
Fe_2O_3	1·42
FeO	21·33
MgO	19·30
CaO	0·43
K_2O	5·42
Na_2O	0·17
H_2O	1·28
SO_3	trace
	100·31

The specific gravity is 3·2757. The rock consists of angular or rounded grains of perfectly fresh olivine up to 2½ mm. in diameter and

dark brown flakes of mica, in which are scattered numerous granules (up to ½ mm.) of blue-green transparent spinel, with some ilmenite. Augite and plagioclase are much less abundant accessories. The high percentage of titanic acid is not completely accounted for by the ilmenite: some of it must belong to the mica. A. H.

A new rock from the Cabo de Gata district.—Pursuing his account of the eruptive rocks of Cabo de Gata in Almeria, southern Spain, A. Osann has given a description of an interesting rock-type which occurs in the hill Cabesso Maria, 6 km. S.W. of the town of Vera, and in small patches to a distance of 8 km. further east (*Zeitschr. d. deutsch. geol. Gesellsch.* Vol. xli. p. 306; 1889.) The various patches are relics of a thin lava-flow overlying Pliocene strata, and the hill named evidently marks the source of eruption. The rock is black, with a pitchy lustre, and shows flakes of pale-brown mica up to 2 mm. in diameter. It also contains amygdaloidal vesicles filled with carbonates and elongated in the direction of flow.

The mica, which is the most striking constituent, shows in thin sections a yellow-brown colour with pleochroism: α, nearly colourless; β, pale brownish; γ, canary yellow: absorption $\beta > \gamma > \alpha$. Even basal cleavage-flakes are therefore markedly dichroic. The colouring is often zonal, the interior of a flake being either lighter or darker than the margin. The flakes are well-formed, and show no magnetite border or other evidence of resorption by the magma. There is also a second generation of mica in the ground-mass, each flake surrounded by a colourless halo in the glassy base. The mica is of the second group, with axial plane (010), small axial angle, and negative bisectrix sensibly oblique to the basal plane, a slightly oblique extinction being observable in parallel light in cross sections of the flakes. The little scales in the ground-mass are grouped in fan-like bunches.

Olivine is abundant in little colourless grains and crystals with included octahedra of brown picotite. It gives rise to carbonates, but only little serpentine. Pyroxene occurs in very pale greenish crystals belonging to the 'effusion-period.' It is remarkable for glass-inclusions in the form of parallel rods thickened at each end, and arranged nearly perpendicular to the vertical axis. Apatite is an accessory. The almost complete absence of iron-ores is striking, only small violet-brown flakes of ilmenite being rarely found. The only mineral visible in hand-specimens is the mica.

Felspar is found only in the variety from Cabesso Maria, in the form of small lath-shaped crystals, with no twinning, and with extinction-angles

ss than 18°. It appears to be not more basic than labradorite bordering
andesine. The Cabesso Maria variety has about equal parts of
ystals and glass: in the normal type the latter predominates. It is in
ction pale-brown and globulitic, and it is not destroyed by acids.
The chemical composition of the rock is represented in column I.

		I.	II.
SiO_2	... ...	55·17	56·96
Al_2O_3	... ...	13·49	12·95
Fe_2O_3	... ...	3·10	7.58
FeO	... ...	3·55	
MnO	... ...	0·39	0·65
MgO	... ...	8·55	6·62
CaO	... ...	3·15	4·63
K_2O	... ...	1·09	4.35
Na_2O	... ...	4·43	2·22
H_2O	... ...	4·27	1·44
CO_2	... ...	3·27	1·94
		100·46	99·34

In chemical as well as mineralogical characters the rock does not agree
ith any of the limburgites, basalts, or andesites, but is most closely
aralleled by the olivine-bearing lamprophyres, of which it appears to be a
lassy, volcanic representative. For comparison the analysis II. is given
f a minette from the Ballon of Alsace (by Delesse). The author considers
ie rock worth distinguishing as a separate type, and proposes the name
erite, from the town Vera. A. H.

Nephrite and Jadeite.—F. W. Clarke and G. P. Merrill have made a
aluable contribution to the jade question in the form of a chemical and
nicroscopical examination of a large suite of specimens in the Museum at
Washington (*Proc. U.S. National Mus.* Vol. xi. p. 115; 1888.) These
ave been collected from a wide range of localities, especially in North and
Central America. Four analyses were made of Alaskan implements; the
verage of these, which agree very closely, is given in column I. All the
ron is reckoned as ferrous oxide, and the alkalies are not estimated.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII
Ignition	1·86	1·66	0·83	0·63	1·81	0·53	0·90	0·9
SiO_2	56·68	57·05	56·73	56·87	58·88	58·18	59·18	58·3
Al_2O_3	1·55	0·85	3·22	1·50	25·93	23·53	22·96	21·6
Fe_2O_3	—	5·00	—	—	—	—	1·87	1·7
FeO	6·55	0·87	5·96	6·33	0·24	1·67		0·7
MnO	trace	trace	trace	trace	—	—	—	—
CaO	12·54	12·42	13·24	13·45	0.40	2·35	1·52	4·9
MgO	20·95	22·22	19·42	21·06	0·36	1·72	0·67	3·0
Na_2O	—	—	—	—	11·64	11·81	12·71	8·1
K_2O	—	—	—	—	0·63	0·77	trace	0·2
	100·13	100·07	99·40	99·84	100·01	100·56	99·81	99·6

These are true nephrites. For comparison four specimens of materi collected *in situ* in the Jade Mountains, Alaska, were examined. Th average of the analyses is given in column II. The comparison of th two columns and the identity of microscopical characters of the two sets specimens show that the implements were probably of home origi Nephrites from other localities, however, show a close similarity of com position: III. is the analysis of a boulder from New Zealand, IV. a implement from Robenhausen, Switzerland. The thin slices of thes specimens show the usual felted and tufted aggregate of minute fibres an scales of an amphibolic mineral. The specific gravities quoted rang between 2·922 and 3·015.

A number of jade ornaments from Mexico were examined. Th specific gravities of twelve specimens ranged from 3·007 to 3·355, an analyses of two gave the results here cited in columns V. and VI., th former having also Cr_2O_3 0·12. These figures indicate normal jadeit Al Na $2SiO_3$, the water being considered to replace the alkalies. Th microscopic structure of these two specimens consists of a granul aggregate of greenish or colourless crystals, shattered and traversed b plates of a micaceous mineral.

Of a large collection of ornaments from Costa Rica two jadeites we analysed, from Sardinal (VII.) and Culebra (VIII.); specific gravities 3·3 and 3·27 respectively. The former showed microscopically a granul aggregate of shapeless crystals with the cleavage and optical properties pyroxene. The latter consisted largely of matted fibres and scales, amo which were imbedded crystal grains of a similar pyroxenic mineral.

The simplest practical method of distinguishing between nephrite a jadeite is by making use of the higher specific gravity of the latter. T

authors doubt the possibility of discriminating them with certainty by their microscopical characters.

Besides these two substances, quartz, fibrolite, saussurite, etc., were found to have afforded material for implements and ornaments from various localities. A. H.

Origin of the graphite of Ceylon.—Graphite is the most important mineral product of Ceylon, and its occurrence there has been recorded and described by various writers, and especially by F. Sandberger. (*Neus. Jahrb. f. Min.*, 1887, Vol. ii. p. 12.) The mineral is coarsely lamellar or fibrous in structure, and encloses quartz, orthoclase, fibrous hornblende, mica, apatite, pyrites, weathered andesine, and chloritic kaolin, besides needles of colourless rutile and acicular pseudomorphs of ilmenite.

J. Walther has recently examined the mode of occurrence of the graphite in the Kaluganga and Kultura district, where it forms veins in a grey gneiss, which is weathered to a depth of 12 metres to a pale-red mass of kaolin, etc., the 'laterite' of the author. The complex branching veins cannot be explained as stratified masses disturbed by faulting. The author dismisses the possible eruptive origin of the graphite with Sandberger's remark that the enclosed pyrites cannot have originated at a high temperature, and that heat would have caused the rutile needles to be reduced by the carbon to metallic titanium [which seems scarcely conclusive]. The theory of an aqueous origin for the graphite is also rejected, because the gneiss and 'laterite' bordering the veins are free from graphite, and there are not even any salbands containing carbonaceous matter. It remains that the graphite was introduced into the veins in a gaseous form. The author does not suppose that it sublimed as carbon, but in the form of one of the hydrocarbons rich in that element. He compares it with the carbon formed by sublimation in the retorts of gas-works. Hydrocarbon compounds are known as exhalations in various parts of the world, and spectrum analysis proves that they play an important part in other worlds less developed than our own. Walther believes that this theory of the origin of graphite by the reducing of hydrocarbon vapours will hold good in some other localities, but does not press it as a universal theory. (*Zeitschr. d. deutsch. geol. Gesellsch.* Vol. xli. p. 359; 1889.) A. H.

Alums and other minerals in Chili.—The province of Tarapaca in Chili is known for its deposits of nitre. Prof. H. Schulze, of Santiago, has recently found there a layer of pure *blödite* (*astrakanite*) 500 m. long by

10 to 40 m. broad, and 0·5 to 0·6 m. thick. In the same locality occurs *tamarugite* (Na_2SO_4, $Al_2S_3O_{12}$, $12H_2O$), a new half-dehydrated soda-alum with glassy lustre, forming slightly bent blades without crystal faces. *Pickeringite* ($MgSO_4$, $Al_2S_3O_{12}$, $22H_2O$), is also found in very fine fibres to a length of 40 cm. All three salts contain a small amount of cobalt, and have a rosy tint in consequence. Massive *hydroboracite* is found near the alum-deposits: the locality is Cerros pintados. In Challacollo, 50 km. farther south, *matlockite*, *cotunnite*, *percylite*, *huantajayite*, *silver-iodide*, *anglesite*, *lead-iodide*, *etc.*, have been produced by the action of saline solutions from argentiferous galena. [*C.* Ochsenius in *Zeitschr. d. deutsch. geol. Gesellsch.*, Vol. xli. p. 371 ; 1889.] A. H.

Heavy liquids for the separation of Minerals.—J. W. Retgers describes some new liquids which attain a higher specific gravity than those at present in use, and may be used to separate minerals whose density is greater than 3·6 (*Neues Jahrb.* 1889 (2), p. 185). The most convenient liquids at present known are Thoulet's solution of mercury and potassium iodide (Sp. gr. = 3·196), Klein's solution of cadmium borowolframate (3·28), Brauns' methylene iodide (3·30), and Rohrbach's solution of mercury and barium iodide (3·58). Retgers finds that the Thoulet, Rohrbach, and Brauns' liquids may all be made more dense by addition of iodine; and the methylene iodide may even be raised to the density of 3·65 by dissolving in it first iodoform and then iodine. All these liquids can be used cold. If molten solids are employed a much greater density can be reached. Those which are most to be recommended are mercury and potassium iodide (4·1), melting point 100°C, iodine (4·0) m.p. 113°, silver nitrate (4·1) m.p. 198°; but the most convenient of all is the mixed iodide and nitrate of silver obtained as a transparent yellow oily liquid by dissolving silver iodide in a warm concentrated solution of silver nitrate. This has a density about 5·0, and melts at the low temperature of 65°—70°; rutile and zircon float in the liquid.

Cold liquids having been used to separate the minerals lighter than 3·6, molten silver nitrate will then separate the group 3·6—4·1 which includes staurolite, pyrope, pleonaste, anatase, corundum, perowskite, and picotite; finally by means of the molten silver iodide and nitrate the group 4·1—5·0 comprising rutile, zircon, chromite, and ilmenite, can be separated, so that the only important heavy mineral remaining will be magnetite. H. A. M.

Jadeite.—The Mineral previously described as Jadeite from Piz Longhin in Bergellthal (See E. von Fellenberg, *Neues Jahrb.* 1889 (1), p.

3) has now been analysed by Professors Rammelsberg and Meyer, and ves to be massive Idocrase, having the same composition as the crase from Monzoni and several other localities. (*Neues Jahrb.* 89 (1), pp. 229, 270.) H. A. M.

Cryptolite.—The Cryptolite which occurs in small crystals in the atite of Tvedestrand, and was originally described as a new mineral n Arendal, by Wöhler, has been examined by Mallard (*Bull. Soc. nc. de Min.* 1887, x. p. 236), who finds it to have all the physical racters of Monazite, with which it is also identical in composition.

H. A. M.

Spodumene from Brazil has been the subject of careful analyses by Jannasch (*Neues Jahrbuch*, 1888 (1), p. 196), whose results agree ely with the previous analyses made by Dölter and Pisani, and confirm accuracy of the formula $(Li, Na)_2O\ Al_2O_3\ 4SiO_2$. The Brazilian dumene is an isomorphous mixture of about 96·5 per cent. of the ium-aluminium-silicate with 3·5 per cent. of the corresponding sodium-ate, and contains 7·45 per cent. of lithia; the author is of opinion all Spodumene analyses which indicate a small percentage of lithia than 6·5) need revision. H. A. M.

The absorption of light in crystals.—W. Ramsay (*Zeits. f. Kryst.* xiii. 87, pp. 97-134) in an elaborate paper continues the researches of in and Laspeyres upon the absorption of light in epidote, and proves t in this mineral the axes of maximum and minimum absorption do not ncide with the principal axes of optical elasticity. It seems to have n generally assumed that there are three rectangular axes of maximum, n and minimum absorption in any crystal, and that these probably ncide with the elasticity axes. In reality, light of each colour has two nite directions of vibration, for which the absorption is a maximum a minimum; in the case of epidote the direction corresponding to t absorption for red light makes an angle of 20° with the maximum sticity axis, while that for green light makes an angle of 35° with the ne. The angle between the directions of greatest and least absorption red light is 82°, and for green light 90°; the dispersion of the bsorption-axes" is in the opposite direction to that of the elasticity s. H. A. M.

REVIEW.

Handbuch der Mineralogie (Erste Lieferung), von C. Hintze. Leipzi
(Veit & Comp.), 1889.

This is the first instalment of what will be a very important treatise
the author, Prof. Hintze, of Breslau, succeeds in carrying his colossal tas
to a successful conclusion.

Most text-books of Mineralogy commence with a "General Part" o
"Introduction," which includes a necessarily incomplete account of Crys
tallography and Chemistry of little use to the student who can consult text
books of those subjects, and of no use to those who want a book
reference on Minerals. Prof. Hintze wisely confines himself to a complet
account of each mineral from the crystallographic, chemical, and miner
logical points of view. Special attention is paid to the associations an
modes of occurrence of the specimens from various localities, and here th
descriptions are made more than usually interesting by arranging them
where possible, not in geographical, but in historical order.

The first part begins with the Silicates, and includes the groups
minerals classed with Olivine, Willemite, Garnet, and Topaz, togeth
with a few others.

The amount of detailed information given may be realised from th
description of Topaz, which extends over 25 pages, and includes 2
analyses, while under Lime-Iron-garnet no less than 71 analyses a
quoted.

There are very complete references to original authorities, and even th
names of authors from whom the figures have been borrowed are give
This is an innovation much to be recommended. The work is of cours
almost entirely a compilation, but is so complete that it must become
standard book of reference. Prof. Hintze hopes to complete it in 3 or
years, and we wish him all success in his undertaking. H. A. M.

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RUNDUM. H. Cretier. Jaarb. Mijn. xiii. p. 317. *Borneo.*

WEYLITE. G. Kunz. Trans. N. Y. Ac. iii. p. 17. *Massachusetts.*

ERALD. A. Stephenson. Trans. N. Y. Ac. iii. p. 38. *N. Carolina.*

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See also Vol. vi. pp. 142, 187, 232; Vol. vii. pp. 111, 261.

Berh. Nat. Ver. Cassel.	Bericht des Vereins fur Natur-Kunde. Cassel.
Boll. Soc. Nap.	Bolletino della Società dei Naturalisti in Napoli.
Bull. Soc. Sav.	Bulletin de la Société d'Histoire Naturelle de Savoie. Chambéry.
Jahresb. Ung. Geol. Anst.	Jahresbericht der k. ungarischen Geologischen Anstalt. Budapest.
Math. Termes. Ert.	Mathematikai es Természettudományi Ertesitö Kiadja a Magyar Tudományos Akademia. Budapest.
Mitth. Ak. Berl.	Mathematische und naturwissenschaftliche Mittheilungen aus den sitzungsberichten der königlich preussischen Akademie der Wissenschaften zu Berlin.
Mitth. Min. Inst. Kiel.	Mittheilungen aus dem Mineralogischen Institut der Universität. Kiel.
Proc. Bath Club.	Proceedings of the Bath Natural History and Antiquarian Field Club. Bath.
Riv. Min.	Rivista di Mineralogia e Cristallografia. Padova.
Tids. Phys. Chem.	Tidsskrift for Physik og Chemi. Kjobenhavn.
Trans. Inst. Min. Eng.	Transactions of the North of England Institute of Mining and Mechanical Engineers. Newcastle-on-Tyne.
Vers. Nat. Aerzt.	Tageblatt der Versammlung deutscher Naturforscher und Aerzte.
Zts. Ges. Erdk. Berl.	Zeitschrift der Gesellschaft für Erdkunde. Berlin.
Zts. Phys. Chem.	Zeitschrift für physikalische Chemie. Leipzig.

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ORIGINALLY PRINTED IN GREAT BRITAIN BY MESSRS. WILLIAMS AND STRAHAM, LONDON. REPRINTED OFFSET LITHO BY BIDDLES LTD., THE CITY PRESS, GUILDFORD, SURREY